Space Weather Technical Forecast

Issued on Monday, 10 October 2022 at 01:18 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares. Active electron Fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with recorded X-ray activity confined to low C-class at GOES16 and 17. The largest flare of the period was a C4.1 at 09/2216UTC, emanating from AR3119 in the northeastern quadrant - one of the most-changed groups in the period. Also of note was a slowly rising and falling C3.9 at 09/1427UTC, with this emanating from the largest and nominally most complex region on the disc, AR3112, which finished the reporting period as an Fhi/Beta-Gamma-Delta. This type of slow-burn flare has been typical of this sunspot group in recent days, with its apparent complexity not yet borne out in activity.

There are five numbered sunspot regions on the current disc, with AR3111 having become indistinct in the northwestern quadrant in the period. All five sunspot groups showed some proliferation over the UTC day, although the more noteworthy groups were near centre-disc. These included the aforementioned AR3112, but also AR3116 to its immediate north which manifested as a Dso/Beta, and AR3119, which has changed the most over the UTC weekend to reach Esi/Beta classification.

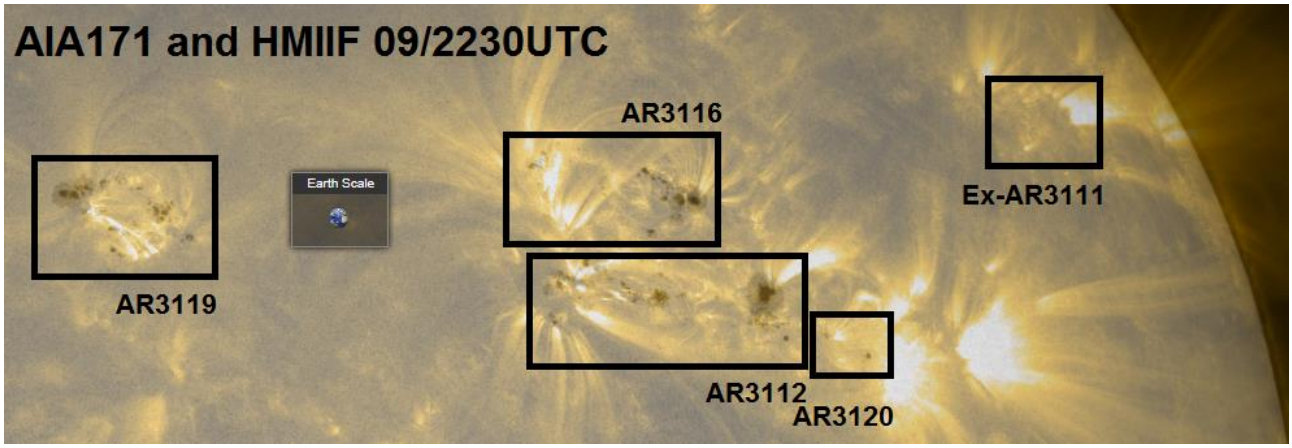

Figure 0: Helioviewer.org derived composite image of many of the current sunspot groups, with Earth and the northwestern limb shown for scale.

There are still a number of filaments on the disc in the solar 'tropics'. One of these showed some movement in the south-central disc later in the UTC afternoon (in Cerro Tololo H-Alpha for example), but did not appear to leave the disc. The main events visible on coronagraph imagery were a large southeast-directed Coronal Mass Ejection (CME), shortly followed by a rear-sided eastward emission, and then later a high latitude far-sided CME - none of which are expected to affect Earth. Finally, at the very end of the period, a dimming was detected in AIA211 in the central

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southeastern quadrant, likely related to a filament lift off. There is not yet any imagery to ascertain if any CME has resulted, however this will be monitored.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1 was Elevated to Strong, with a rising trend evident that may be due to an otherwise seamless transition between positive polarity coronal holes, perhaps CH28 or 30 into 29. The phi angle was accordingly mostly positive (away from the Sun), but with a change to negative after 09/2230UTC, with this perhaps due to an SSBC.

The solar wind speed rose from around 525km/s to 575 in the period, with brief peaks nearer 625 at the very end of the 24 hours. The solar wind density was slightly above the long-term background, with peaks in the low teens ppcc, falling away slightly later in the period. The IMF was within its typical background range, with a peak near 7nT and a falling tendency observed. The north-south component was small-scale but mainly anti-aligned with Earth's field, with peaks of -6 and +4nT observed, and with a more neutral variation observed from 09/1900UTC.

The net result of the above solar wind measures was for provisionally Quiet to Active Kp indices, peaking with a Kp 4+ in the 12-15UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at Background levels.

High energy electron flux (greater than 2MeV) has been at Moderate to High levels, peaking at 3330pfu at 09/1715UTC. The associated 24-hour fluence has been above the Active (1e8 integrated pfu) threshold throughout. The 10/0001UTC observation was 1.07e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, but with a Chance of rising to Moderate. The outlook is for a greater chance of activity given far side soundings and bright flux over the eastern limb, however the degree to which this manifests will be determined as and when any regions arrive. None of the more noteworthy groups on the disc leave the western limb in the four days.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the forecast, however the 07/0730UTC filament eruption CME may pass close to the Earth overnight UTC 11 into 12 October, giving some very slight peripheral influences.

Otherwise, ongoing fast winds, most probably from CH29/+ are likely to gradually ease through the period, approaching or falling to background by midweek UTC (12 October).

Initial Active intervals should become less likely with time, falling to mainly Quiet by midweek with the resumption of a slow regime.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be at Background, but with a daily Slight Chance of rising in response to any large flares, primarily from AR3112 or AR3116 in the northwest disc.

The high energy electron flux (greater than 2 MeV) is likely to persist at mainly Moderate to High levels, perhaps briefly suppressed at first by any resulting geomagnetic activity from CH29, although counts have been relatively impervious to this so far. The associated electron fluence is forecast to persist at Active levels, but with confidence declining later in the period.

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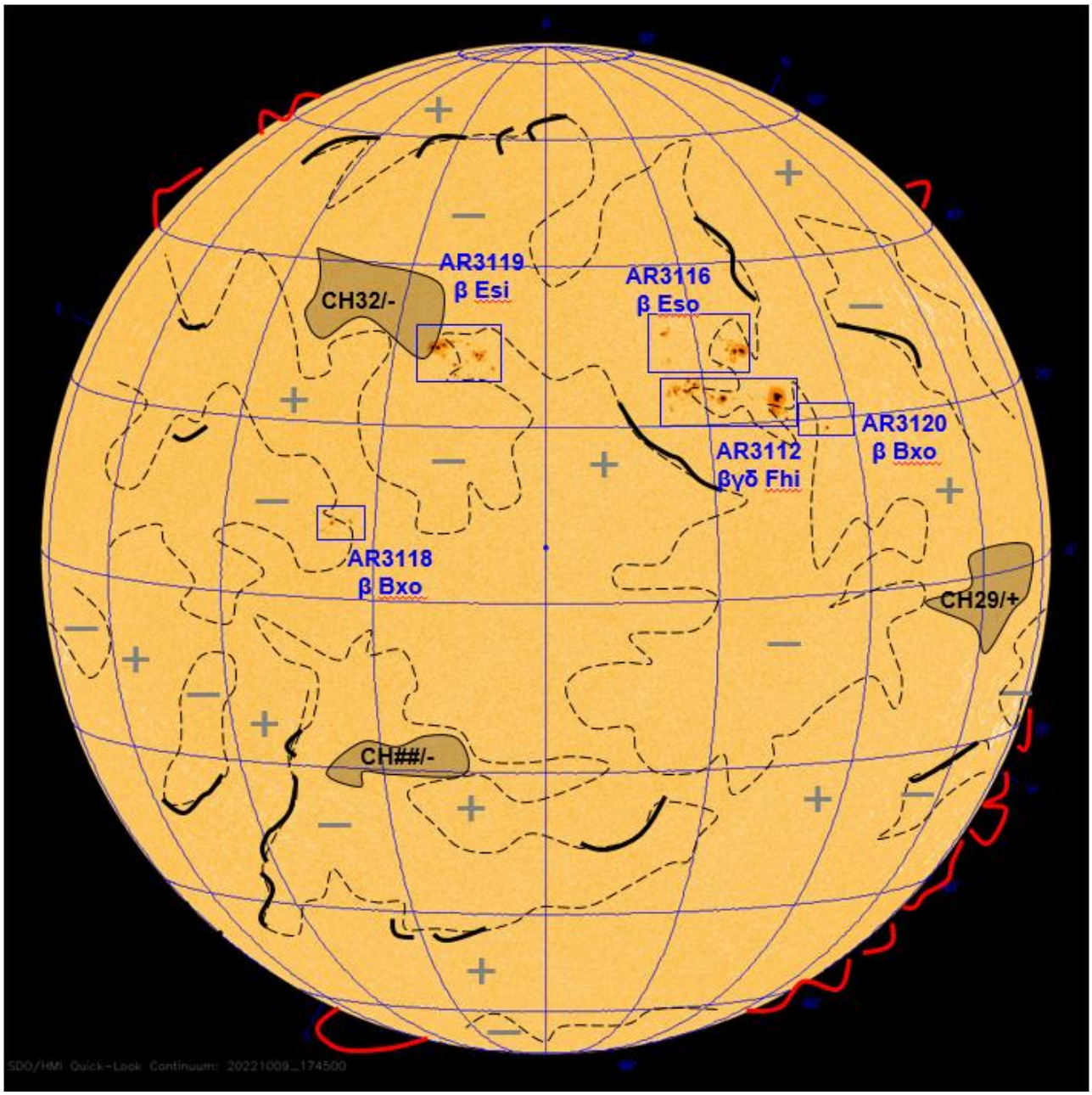
Figure 1. Solar Analysis Valid 09/1745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in the forecast, although the 07/0730UTC may slightly perturb the solar wind around the turn of the UTC day 11 into 12 October.

The current fast wind from CH29/+ is likely to be the predominant feature of the coming four-day forecast, and as such should be near its peak at present, giving a Chance of occasional Active intervals. This risk should diminish with time, such that by midweek Quiet conditions should have reliably returned, in the absence of any transient activity.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Radio Blackouts - X-Ray Flares:

There are now five sunspot regions on the disc, and the Carrington longitudes of all should remain on the Earth-facing side regardless of the fates of these spots in terms of development or decay over the four days.

Far-side soundings suggest that there may be a succession of large regions due over the eastern solar horizon through the course of the coming UTC working week, with this implying a negative outlook in terms of the risk of flares, although this will be confirmed as and when they present over the eastern limb for analysis.

There is therefore a flat trend in flare risk at present, with AR3112 dominating, although the risk has been revised downwards significantly from raw values arising from historical precedents. Reasons for doing so include AR3112's penchant for small long-period flares; its age; its lack of shear for mostly lying at one (extended) solar latitude. The threat of a Mt Wilson delta spot in its leading portion still mean that this group could develop rapidly however, and a daily Chance of M-class flares is therefore maintained.

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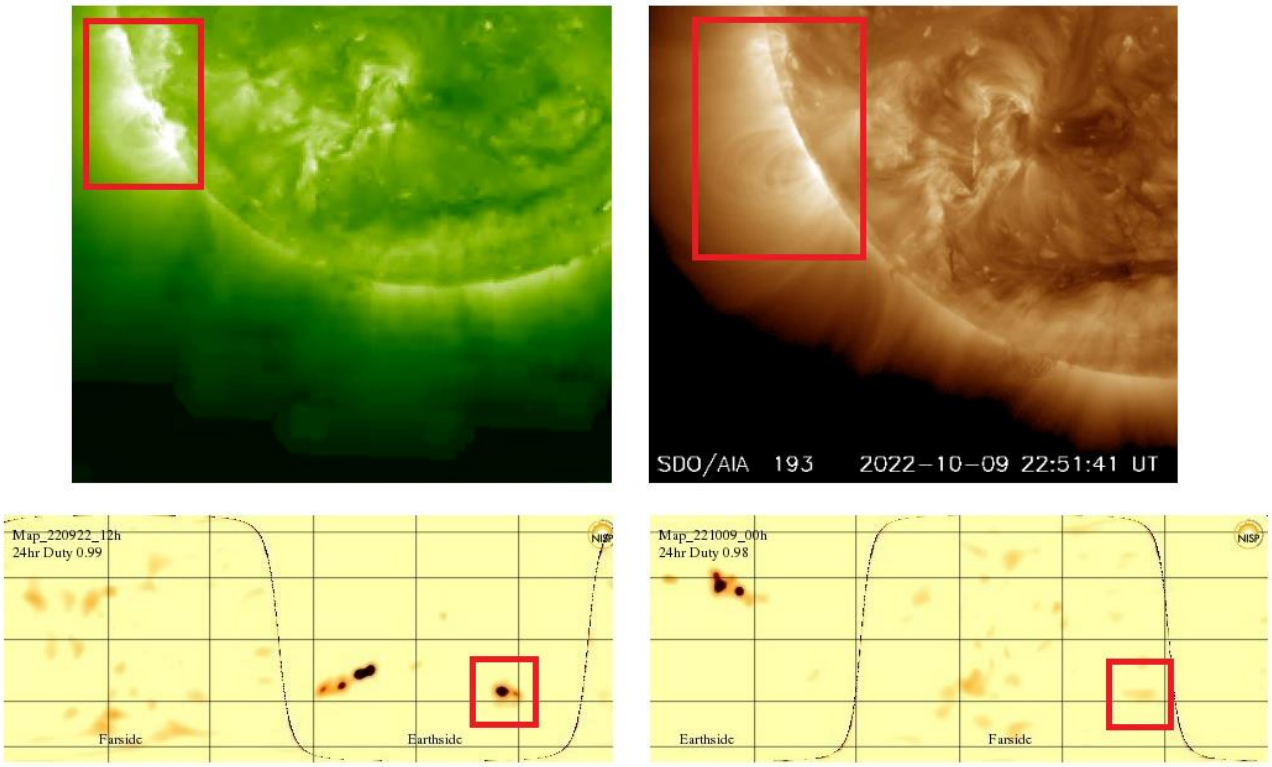
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Imagery of possible upcoming region(s) in the new UTC week: clockwise from top left: STEREO A EUVI195, showing large bright flux region on its southeastern limb at 09/1945UTC; AIA195 imagery from L1 (around 20 degrees further west); far-side sounding of a potential surviving anomaly; that may correspond the the pictured large sunspot group – shown here as it appeared on 22 September



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is currently at Background levels.

While there has yet to be any notable flaring from AR3112 and AR3116 in particular, their westward advance and nominal complexity mean that there is a residual slightly rising chance of S1, although the rise is too slight to represent in the probability tables. Any arriving eastern horizon regions are thought unlikely to contribute for some time yet to this risk.

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Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux as observed by GOES16 has proved quite resilient to periods of Active geomagnetic activity seen in the past few days, and has continued a marginal but persistent trend about High flux, which has resulted in a flat fluence trend slightly above Active.

Given that the threat of significant geomagnetic activity is greatest earlier on in the four-day forecast period (from the incumbent fast wind from CH29), the chances of the current diurnal oscillation being disturbed or re-set at lower flux levels is highest to start the working week. Should this not occur, flux and fluence could well survive the period relatively unaltered, although given the extreme proximity of the fluence to the threshold, this still only offers relatively low confidence in remaining so, as even a very minor change may result in a lasting exit from Active.

Overall, Active fluence is considered 'odds on' throughout, although this is only slightly better than 'evens' beyond the immediate term for reasons described above.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	60	60	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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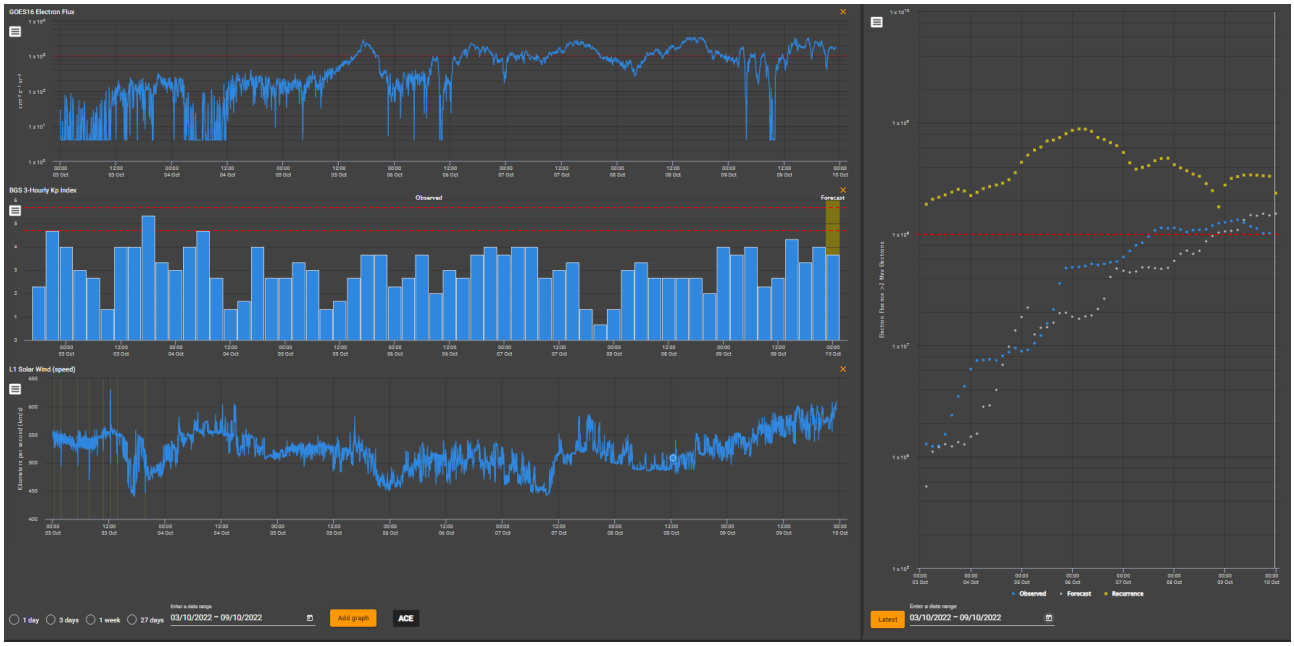
Figure 3: Clockwise from top left: 2MeV high energy electron flux in the past week at GOES16; associated 24-hour integrated electron fluence (blue dots); L1 solar wind speed at DSCOVR showing fast winds from CH28, 30 and 29; and BGS-recorded 3-hourly Kp indices



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